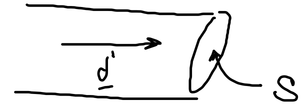
## Correnti elettriche

$$I = \frac{\Delta Q}{\Delta t} \qquad [I] = \text{Ampere} = C/s$$

$$I = j \cdot S$$

$$j = n q v_d$$

dens. portatori




$n \sim 10^{28}$ part/$m^3$

$v_d \sim$ mm/s

## Resistenza e resistività

Ohmici

$$j = \sigma E$$

conducibilità

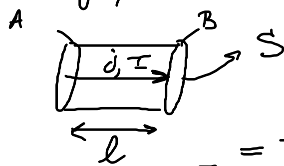
Non ohmici

$$j \neq \sigma E$$

Semiconduttori

$$\sigma \overset{def}{=} \rho^{-1}$$

resistività




$E \approx$ uniforme

Legge di Ohm: $\Delta V = E \cdot l = \frac{j}{\sigma} l = \frac{I}{\sigma}\frac{1}{S} l = RI$

$\hookrightarrow j = I/S$

$$R \overset{def}{=} \frac{l}{\sigma S}$$

$\rho$, $\sigma$ dipende solo dal materiale

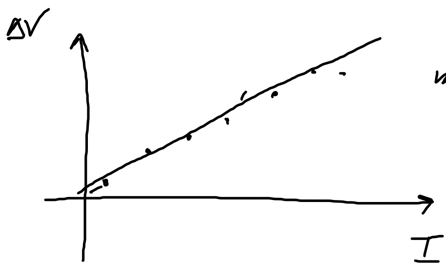
$R$ dipende da materiale e geometria $\quad R = \rho \dfrac{l}{S}$

$\Delta V = R I \qquad [R] = \left[\dfrac{\Delta V}{I}\right] = \dfrac{V}{A}$ oggi $=$ Ohm $= \Omega$

$$[\rho] = \frac{\Omega \cdot m^2}{m} = \Omega \cdot m$$

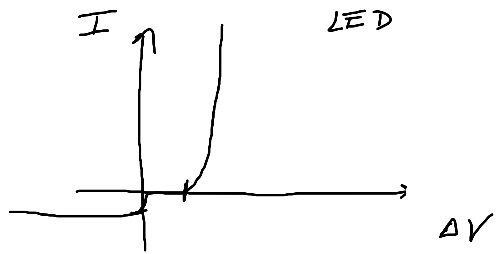
$$[\sigma] = \Omega^{-1} m^{-1}$$

Materiale ohmico $\quad \Delta V = R I$



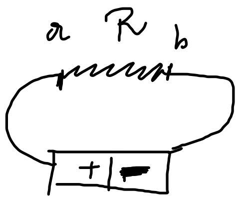

$m_{retta} = R$

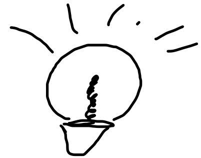
Materiale non ohmico




LED

# Potenza elettrica



Energia dissipata

$$\Delta V_{ab} = RI$$

$$\Delta U = q \cdot \Delta V = qRI$$

$$P = \frac{d}{dt}\Delta U = \frac{d}{dt}(qRI) = RI\overbrace{\frac{dq}{dt}}^{I} = RI^2$$

$$\Omega \cdot A^2$$

Watt

$$\Delta V = RI$$

$$P = \overbrace{\Delta V}^{RI} \cdot I = \frac{(\Delta V)^2}{R}$$

Centrale elettrica

$P_{elettrica}$ — utilizzatore

$$P_{elettrica} = P_{utile} + P_{perdite\ di\ linea}$$

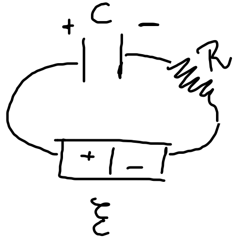
$$P = RI^2 \quad , \quad R = \rho \frac{l}{S}$$

Linee di trasmissione: $I$ bassa

$$P_{elettrica} = \Delta V\, I$$

Trasformatore

# Carica e scarica di un condensatore




$$\underbrace{\begin{pmatrix}\text{Energia immessa}\\ \text{nel circuito}\end{pmatrix}}_{\text{Batteria}} = \underbrace{\begin{pmatrix}\text{Energia}\\ \text{accumulata}\\ \text{nel circuito}\end{pmatrix}}_{\text{Condensatore}} + \underbrace{\begin{pmatrix}\text{Energia}\\ \text{dissipata}\end{pmatrix}}_{\text{Resistenza}}$$

$$\cancel{q}\,\mathcal{E} = \cancel{q}\,\Delta V_C + \cancel{q}\,\Delta V_R \quad ; \quad \mathcal{E} = \Delta V_C + \Delta V_R$$

$$C = \frac{q}{\Delta V_C} \qquad \Delta V_R = RI \qquad \mathcal{E} = \frac{q}{C} + RI$$

$$I = \frac{dq}{dt} \Rightarrow \mathcal{E} = \frac{q}{C} + R\frac{dq}{dt} \qquad q = q(t)$$

eq. differenziale I ordine a coeff. costanti

Separazione di variabili

$$R\frac{dq}{dt} = \mathcal{E} - \frac{q}{C} \quad ; \quad \frac{dq}{dt} = \frac{\mathcal{E}}{R} - \frac{q}{RC} \rightarrow$$

dimensioni di un tempo

$\tau = RC$

$$\frac{dt}{\frac{\varepsilon}{R}-\frac{q}{\tau}} \times \frac{dq}{dt} = \left(\frac{\varepsilon}{R}-\frac{q}{\tau}\right) \times \frac{dt}{\frac{\varepsilon}{R}-\frac{q}{\tau}}$$

$$\frac{1}{\tau}\,\frac{dq}{\frac{\varepsilon}{R}-\frac{q}{\tau}} = \frac{dt}{\tau}\;;\quad \underbrace{\int_0^{q(t)} \frac{dq}{-\varepsilon C+q}} = -\int_0^{t}\frac{dt}{\tau}$$

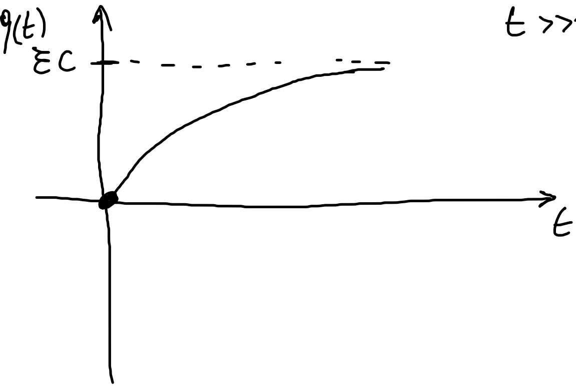
$$\ln\Big[q-\varepsilon C\Big]_0^{q(t)} = -\frac{1}{\tau}\cdot t$$

$$\boxed{q(t) = \varepsilon C\left(1-e^{-t/\tau}\right)}$$

$$\ln\left[q-\varepsilon C\right] - \ln\left(-\varepsilon C\right) = -t/\tau$$

$$\ln\left(-\frac{q-\varepsilon C}{\varepsilon C}\right) = -t/\tau \qquad \frac{\varepsilon C-q}{\varepsilon C} = e^{-t/\tau}\,;$$

$q(t) = \mathcal{E}C\,(1 - e^{-t/\tau})$




$t = 0: \; q(0) = \mathcal{E}C\,(\cancel{1} - \cancel{1}) = 0$

$t \gg \tau: \; e^{-t/\tau} \approx 0 \Rightarrow q(t \gg \tau) = \mathcal{E}C$

a fine carica:

$C = \dfrac{q}{\mathcal{E}} \Rightarrow q = \mathcal{E}C$

In quanto tempo $t^*$ si carica per metà?

$\dfrac{\cancel{\mathcal{E}C}}{2} = \cancel{\mathcal{E}C}\,(1 - e^{-t^*/\tau})$;

$e^{-t^*/\tau} = \dfrac{1}{2}$; $\; -t^*/\tau = \ln\left(\dfrac{1}{2}\right) = -\ln 2$

In quanto tempo si carica al 99%?

$0.99\,\mathcal{E}C = \ldots$

$t = 4.6\,RC$

$t^* = \ln 2\,\tau \simeq 0.693\,\tau$